

## CLAIMS

1. Logical element comprising:

an optical junction;

at least two optical inlets, coupled to said optical junction; and

at least one optical outlet coupled to said optical junction.

2. The logical element according to claim 1, further comprising at least one detector for detecting at least one property of light received from said at least one optical outlet.

3. The logical element according to claim 2, wherein said at least one property of said light comprises the phase relationship between components of said light, wherein each said components is defined by an internal phase shift.

4. The logical element according to claim 2, wherein at least one of said at least one detector is an optical detector.

5. The logical element according to claim 4, wherein said at least one optical detector is positioned to measure the light intensity in at least one specific zone of the interference pattern formed by said light received from said at least one optical outlet.

6. The logical element according to claim 5, wherein said at least one zone comprises a Fresnel Zone.

5 7. The logical element according to claim 6, wherein said Fresnel Zone is the central Fresnel Zone.

8. The logical element according to claim 1, further comprising an electro-optic converter, coupled to at least one of said optical inlets.

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9. The logical element according to claim 8, wherein said electro-optic converter comprises at least one light-emitting diode.

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10. The logical element according to claim 1, further comprising an opto-electric converter, coupled to at least one of said at least one optical outlet.

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11. The logical element according to claim 8, further comprising an opto-electric converter, coupled to at least one of said at least one optical outlet.

12. The logical element according to claim 10, wherein said opto-electric converter comprises at least one photodiode.

13. The logical element according to claim 1, further comprising light separator for separating into components light received from at least one of said at least one optical outlet, wherein said components are defined by at least one characteristic.

14. The logical element according to claim 13, wherein said at least one characteristic is the wavelength of said light.

15. The logical element according to claim 14, wherein said light separator comprises at least one dispersive material.

16. The logical element according to claim 14, wherein said light separator comprises:

at least one beam-splitter; and

at least two wavelength filters.

17. The logical element according to claim 14, wherein said light separator comprises at least one birefringent material.

18. The logical element according to claim 14, wherein said light separator comprises:

at least one beam-splitter; and

at least two polarizers.

19. Optical circuitry comprising a plurality of optical circuitry elements,  
wherein each of said optical circuitry elements comprises at least one  
5 optical logical element, said at least one optical logical element  
comprising:

an optical junction;

at least two optical inlets, coupled to said optical junction; and

at least one optical outlet coupled to said optical junction.

10 20. The optical circuitry according to claim 19, wherein said at least one  
optical logical element further comprises at least one detector for  
detecting at least one property of light received from said at least one  
optical outlet.

15 21. The optical circuitry according to claim 20, wherein said at least one  
property of said light is the phase relationship between components  
of said light, wherein each said components is defined by an internal  
phase shift.

20 22. The optical circuitry according to claim 20, wherein said at least one  
detector is positioned to measure the light intensity in at least one  
specific zone of the interference pattern formed by said light.

23. The optical circuitry according to claim 22, wherein said at least one zone comprises a Fresnel Zone.

5 24. The optical circuitry according to claim 23, wherein said Fresnel Zone is the central Fresnel Zone.

10 25. The optical circuitry according to claim 19, wherein at least one of said optical circuitry elements further comprises at least one phase shifter.

15 26. The optical circuitry according to claim 25, wherein said at least one phase shifter shifts the phase of light passing there through by one half of a cycle.

20 27. The optical circuitry according to claim 25, wherein at least one of said at least one phase shifter is coupled to at least one of said at least one optical outlet.

28. The optical circuitry according to claim 25, wherein at least one of said at least one phase shifter is coupled to at least one of said at least two optical inlets.

29. The optical circuitry according to claim 25, wherein at least one of said at least one phase shifter is coupled to at least one optical outlet of at least one of said at least one optical logical element, and further to at least one optical inlet of at least another of said at least one optical logical element.

30. The optical circuitry according to claim 19, wherein at least one of said optical circuitry elements comprises at least one optical resistor.

31. The optical circuitry according to claim 30, wherein at least one of said at least one optical resistor is coupled to at least one of said at least one optical outlet.

32. The optical circuitry according to claim 30, wherein at least one of said at least one optical resistor is coupled to at least one of said at least two optical inlets.

33. The optical circuitry according to claim 30, wherein at least one of said at least one optical resistor is coupled to at least one optical outlet of at least one of said at least one optical logical element, and further to at least one optical inlet of at least another of said at least one optical logical element.

34. The optical circuitry according to claim 19, further comprising a plurality of optical logical elements, wherein at least one optical outlet of at least one of said optical logical elements is optically coupled to at least one optical inlet of at least another one of said optical logical elements.

35. The optical circuitry according to claim 34, having a three-dimensional structure and comprising at least two layers,

wherein each of said at least two layers comprises an optical circuitry portion; and

wherein at least two of said at least two layers are optically coupled.

36. Optical device for performing a logical operation, the optical device comprising:

an optical junction;

at least two optical inlets for receiving at least two incoming light beams; and

at least one optical outlet at which at least one outgoing light beam is emitted,

wherein said at least two incoming light beams are superposed at said optical junction, thereby producing said at least one outgoing light beam.

5 37. The optical device according to claim 36, wherein at least one property of said at least one outgoing light beam depends on the phase shift of said at least two incoming light beams.

10 38. The optical junction according to claim 37, wherein at least one property of said at least one outgoing light beam depends on the amplitudes of said at least two incoming light beams.

15 39. Method for performing logical functions using at least one group of light beams, each said at least one group of light beams comprising a plurality of light beams, each said at least one group of light beams being defined by at least one property and shares a distinctive characteristic, the method comprising the procedure of superposing said plurality of light beams in an optical junction, thereby producing at least one superposed light beam sharing said distinctive  
20 characteristic.

40. The method according to claim 39, wherein said at least one property includes the phase shift.



41. The method according to claim 39, wherein said at least one property includes the amplitude.

5 42. The method according to claim 39, wherein each of said light beams of said plurality of light beams has a respective phase shift and amplitude.

10 43. The method according to claim 42, wherein each combination of said phases shifts and amplitudes defines a predetermined logical value.

44. The method according to claim 39, wherein said distinctive characteristic is selected from the list consisting of:  
a wavelength; and  
15 a polarization direction.

45. The method according to claim 39, further comprising the procedure of detecting said at least one property of said at least one superposed light beam.

20 46. The method according to claim 45, further comprising the procedure of determining a logical value for the detected at least one property of said at least one superposed light beam.

47. The method according to claim 39, further comprising the preliminary procedure of producing at least one of said at least one group of light beams from at least one light source.

5 48. The method according to claim 39, further comprising the preliminary procedure of producing at least one of said at least one group of light beams in response to at least one electrical signal.

10 49. The method according to claim 48, wherein at least one of said at least one group of light beams is produced from said at least one electrical signal using at least one light emitting diode.

15 50. The method according to claim 45, further comprising the procedure of producing at least one electrical signal in correlation to the detected at least one property of said at least one superposed light beam.

51. The method according to claim 50, wherein said at least one electrical signal is produced using at least one photodiode.

20 52. The method according to claim 39, wherein said at least one property of said at least one superposed light beam comprises the phase shift difference among at least two components of said at least one

superposed light beam, wherein each said at least two components is defined by an internal phase shift.

53. The method according to claim 52, wherein the logical values defined  
5 by said phase shift difference comprise:

a first logical value for a first fraction portion of the number of cycles in a first phase shift difference among said at least two components; and

10 a second logical value for a second fraction portion of the number of cycles in a second phase shift difference among said at least two components.

54. The method according to claim 53, wherein said first fraction portion and said second fraction portion are zero and half a cycle,  
15 respectively.

55. The method according to claim 39, wherein said at least one property of said at least one superposed light beam is detected using at least one optical detector.

20 56. The method according to claim 39, wherein said at least one property of said at least one superposed light beam is detected by measuring light intensity in at least one predetermined location.

57. The method according to claim 56, wherein said at least one predetermined location is a Fresnel Zone.

5 58. The method according to claim 57, wherein said Fresnel Zone is the central Fresnel Zone.

59. The method according to claim 39, wherein said at least one property of said at least one superposed light beam is the amplitude of at least one component of said at least one superposed light beam, wherein each said at least one component is defined by an internal phase shift.

60. The method according to claim 39, wherein said at least one property of said at least one superposed light beam is the intensity of said superposed light beam.

61. The method according to claim 39, further comprising the preliminary procedure of changing the phase shift of at least one light beam of said group of light beams.

62. The method according to claim 39, further comprising the preliminary procedure of changing the phase shift of at least one of said at least one superposed light beam.

5 63. The method according to claim 61, wherein said phase shift of at least one light beam of said group of light beams is changed by one half of a cycle.

10 64. The method according to claim 63, wherein said procedure of changing further comprises a sub-procedure of directing at least one of said light beams through at least one phase shifter.

15 65. The method according to claim 64, wherein said phase shifter is made of a material having an index of refraction which is different than the index of refraction of a reference material.

20 66. The method according to claim 64, wherein said phase shifter is made of a conveying medium, the length of said conveying medium is different than that of a reference conveying medium.

67. The method according to claim 39, wherein said at least one group of light beams comprises a plurality of groups of light beams, each of said groups yields a plurality of respective superposed light beams,

all said respective superposed light beams are superposed into a single superposed light beam, the method further comprising the procedure of separating said single superposed light beam into said respective superposed light beams.

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68. The method according to claim 67, wherein said at least one property is the wavelength of said light beams.

69. The method according to claim 68, wherein said procedure of separating further comprises a sub-procedure of directing at least one of said superposed light beams through at least one dispersive material.

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70. The method according to claim 69, wherein said procedure of separating further comprises the sub-procedures of:

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splitting said single superposed light beam into a plurality of partial single superposed light beams; and

directing each said partial single superposed light beams through a wavelength filter, wherein each of said wavelength filters admits only light of a wavelength which is substantially equal to the wavelength of a respective group of said at least one group of light beams.

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71. The method according to claim 70, wherein said at least one property is the state of polarization of said at least one group of light beams.

72. The method according to claim 71, wherein said procedure of separating further comprises a sub-procedure of directing at least one of said superposed light beams through at least one birefringent material.

73. The method according to claim 68, wherein said procedure of separating further comprises the sub-procedures of:

splitting said single superposed light beam into a plurality of partial single superposed light beams; and

directing each said partial single superposed light beams through a respective polarization filter, wherein each of said polarization filters admits only light whose state of polarization is substantially equal to the state of polarization of a respective group of said at least one group of light beams.

74. The method according to claim 39, further comprising the procedure of superposing said at least one superposed light beam on at least one additional light beam in at least one additional optical junction.

75. The method according to claim 74, wherein at least one outlet of said optical junction is optically coupled to at least one inlet of said additional optical junction.

5 76. The method according to claim 74, further comprising the procedure of changing the amplitude of said at least one superposed light beam before said procedure of superposing said at least one superposed light beam on said at least one additional light beam.

10 77. The method according to claim 76, wherein said procedure of changing further comprises a sub-procedure of reducing said amplitude, by employing at least one optical resistor.

15 78. The method according to claim 76, wherein said procedure of changing further comprises a sub-procedure of equalizing said amplitude to the amplitude of said at least one additional light beam, by employing at least one optical resistor.